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SHAPING THE CONTEXT OF HEALTH: A Review of Environmental and Policy Approaches in the Prevention of Chronic Diseases

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■ **Abstract** Given the growing attention on how environmental and policy interventions can affect chronic disease burden, our objectives are to describe (*a*) effective and promising interventions to address tobacco use, physical activity, and healthy eating and (*b*) lessons learned from the literature and practice experience in applying environmental and policy approaches. A total of 17 interventions were reviewed, organized across 3 domains affecting the physical environment/access, economic environment, and communication environment. Many of these interventions are effective. Several lessons are important to consider, such as the need to start with environmental and policy approaches, intervene comprehensively and across multiple levels, make use of economic evaluations, make better use of existing analytic tools, understand the politics and local context, address health disparities, and conduct sound policy research.

INTRODUCTION

The origins of modern public health can be traced back to epidemics of now uncommon infectious diseases such as cholera, plague, and leprosy (127). As these diseases were controlled over the past two centuries, the United States and other countries have experienced a dramatic shift toward chronic diseases as the leading causes of death and disability (16, 141). In 1900, the three leading causes of death were pneumonia and influenza; tuberculosis; and gastritis, enteritis, and colitis. These diseases accounted for nearly one third of all deaths. Today, heart disease, cancer, and stroke are the three leading causes of death, accounting for almost two thirds of all deaths. These and other chronic diseases are characterized

by a complex interaction of risk factors, a noncontagious origin, a long latent period between risk factor exposure and clinical occurrence of disease, a long period of illness, and multiple risk factor etiology (86).

There has been growing attention on how environmental and policy interventions can affect chronic disease burden (18, 48, 70, 85). Such interventions are aimed at changing the physical and sociopolitical environments (111). Environmental and policy approaches are designed to provide opportunities, support, and cues to help people develop healthier behaviors. These approaches serve as an important complement to individual-level programs. For example, environmental and policy changes can benefit all people exposed to the environment rather than focusing on changing the behavior of one person at a time. Alternations in the physical or policy environment may directly affect behaviors (e.g., the influence of the price of tobacco on consumption) or they may alter social norms (e.g., restrictions on smoking in public places). Importantly, environmental and policy approaches are often more permanent than many public health programs focused on individual-level behavioral change.

Although chronic disease practitioners and public health agency leaders value scientific knowledge as a basis for decision making (14), systematic evidence is not always available across a range of risk factors and populations. Practitioners often seek expert advice when searching for effective programs and policies. As an example, an expert panel (i.e., the Task Force on Community Preventive Services) supported by the Centers for Disease Control and Prevention has published *The Guide to Community Preventive Services: What Works to Promote Health?* (i.e., the Community Guide) (145). Evidence-based reviews and summaries ("best practices") have been useful across many types of chronic disease prevention programs (22, 24).

The primary purposes of this paper are to describe (*a*) effective and promising interventions to address tobacco use, physical activity, and healthy eating and (*b*) lessons learned from the literature and practical experience in applying environmental and policy approaches.

A FRAMEWORK FOR THE PREVENTION OF CHRONIC DISEASES THROUGH ENVIRONMENTAL AND POLICY CHANGE

A general conceptual framework (Figure 1) illustrates the relationships between a variety of environmental and policy interventions (those altering the physical environment, the economic environment, or the communication environment); the necessary resources and shifts in norms; changes in risk factors; and long-term chronic disease outcomes. Each of the model domains was derived by common evidence across the target behaviors of tobacco, physical activity, and diet. Although the social environment is not considered as a separate domain, it is directly and indirectly influenced by the domains in Figure 1. For example, the

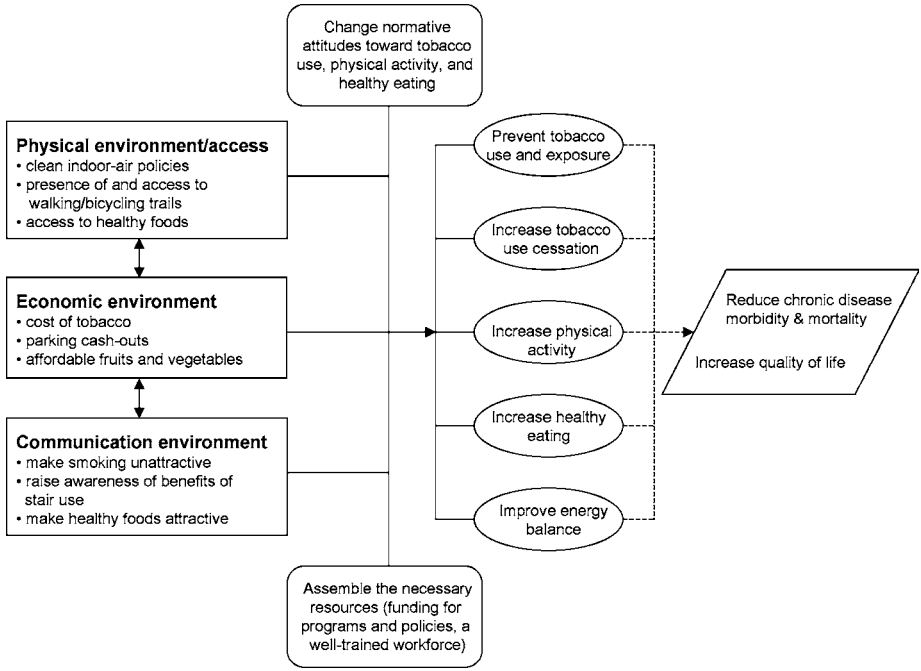

Figure 1 Conceptual framework for understanding the prevention of chronic diseases through environmental and policy approaches.

presence of healthy foods or places to exercise (in the Physical environment/Access domain) is likely to influence social norms related to healthy eating and physical activity.

In many instances, the outcomes in Figure 1 are not independent. For example, improvements in physical activity and eating patterns would also improve energy balance (28). Although we apply the framework to primary prevention of chronic diseases, this type of model (especially the domains in the rectangles) is likely to be applicable to many other public health issues.

EFFECTIVE AND PROMISING INTERVENTIONS

This review focuses on primary prevention of chronic diseases, i.e., risk reduction among asymptomatic persons to reduce the likelihood of development of chronic disease. We cover three important risk factors: tobacco use, physical inactivity, and unhealthy diet that account for 33% of the annual deaths in the United States (89, 90). There is also an extensive literature on secondary prevention (e.g., cancer screening) and tertiary prevention (e.g., preventing complications and/or

recurrence of cerebrovascular disease). When possible, we rely on the systematic reviews from the Community Guide. The Guide categorizes comparative studies of interventions and takes into account both study design and the quality of the study execution (11, 12, 126). Community Guide recommendations for use are based primarily on the evidence of effectiveness reported in a "best-evidence" subset of the identified studies. As of August 2005, reviews were completed for tobacco and physical activity but are still in progress for diet interventions. When evidence of effectiveness is not clearly documented yet there is high face validity or evidence from another area of public health, the intervention is labeled in this review as a "promising practice." All interventions are organized within the three domains in Figure 1.

Tobacco Use Reduction

Among the three chronic disease risk factors covered in this review, tobacco has the most robust group of research-tested environmental and policy interventions. It therefore allows us to consider potential mechanisms of change. There are at least three types of environmental effects: policies that shape the (*a*) behavioral environment, (*b*) financial environment, and (*c*) communication environment (Tables 1, 2). Specifically, countries, states, and communities can reduce tobacco harm by reducing opportunities to use tobacco products, making it more expensive to use tobacco (and cheaper to quit using tobacco), and making smoking less attractive, especially to youth.

PHYSICAL ENVIRONMENT/ACCESS

Clean indoor air Clean indoor air laws and regulations reduce exposure to tobacco smoke and restrict opportunities to use tobacco by limiting where and when people can smoke. Since 1971, when the Surgeon General first called for a governmental ban on smoking in public places, a wide variety of national, state, local,

TABLE 1 Framework for understanding environmental and policy approaches to tobacco control

Type of environmental shift	Types of policies	Environmental/Policy mechanism
Physical environment/access	• Clean indoor air • Restricting youth access	• Reduce opportunities to obtain and use tobacco products
Economic environment	• Increase cost of tobacco • Reduce cost of cessation services	• Make smoking more expensive and quitting less expensive
Communication environment	• Advertising restrictions • Warning labels	• Make smoking less attractive

TABLE 2 Summary of environmental and policy interventions to prevent chronic diseases

Category/Intervention	Examples of intervention components	Effectiveness*	Sites/populations involved	Other notes
Tobacco use				
Clean indoor air	• Bans or restrictions on smoking in public spaces and public or private workplaces	Strong evidence	Wide variety of studies at the organization, community, state, and national level examining the effects of CIA policies in worksites, restaurants, public transportation, schools, and other settings	
Restricting youth access to tobacco	• Enactment and enforcement of sales laws directed at retailers • Retailer or community education about youth access • Laws directed at youth purchase, use, or possession of tobacco products	Insufficient evidence	Large variety of community studies in the United States	Although retail laws and community education can change retail behavior, there is little evidence that these laws and policies can influence youth tobacco use
Taxes and pricing	• Increase price of tobacco products through state and federal excise taxes	Strong evidence	A wide variety of econometric, evaluation and simulation studies examining the effects of price increases. Price effects have been examined in many developed and developing countries	
Reducing cessation costs	• Reduce client costs of cessation services	Sufficient evidence	Small number of studies of insurance coverage. Small number of studies of national health care coverage of cessations services	Studies also found that restrictions on product coverage and availability may inhibit access, even when costs are covered

(*Continued*)

TABLE 2 (*Continued*)

Category/Intervention	Examples of intervention components	Effectiveness*	Sites/populations involved	Other notes
Advertising restrictions	• Restriction of advertising by media (e.g., television, radio, billboards) • Restriction of marketing to specific populations (i.e., youth)	Promising evidence	Numerous studies, most often of nationwide bans or restrictions	Data and methodological challenges have limited the ability to detect effects. Only comprehensive bans show noticeable effects
Product warning labels	• Requirements to place health warning labels on tobacco products • Requirements to include health warning information in tobacco advertising and marketing	Promising evidence	Numerous studies of adult and youth in the United States. More recent studies of newer warning labels in other countries	
Physical activity				
Access to facilities	• Increased access to fitness centers or community centers • Building walking/biking trails • Focus on recreational activity	Strong evidence	Diverse settings including worksites, universities, federal agencies, and communities	Only one study in ethnically diverse populations
Urban planning & policy	• Zoning regulations and building codes • Improved street lighting Infrastructure projects that increase the ease and safety of street crossing • Policies to ensure sidewalk continuity	Sufficient evidence	Includes a variety of geographic scales—from a few blocks to an entire community. Few studies are available among minority populations	Although effect sizes were generally large, all but 3 studies used cross-sectional designs

Transportation policy	• Changing roadway design standards • Expanding public transportation services • Subsidizing public transportation	Insufficient evidence	2 U.S. studies and 1 Canadian study	Other benefits may include air quality, increased commerce, lack of traffic congestion
School-based physical education	• Adding new PE classes • Lengthening existing PE classes • Increasing physical activity during PE class without necessarily lengthening class time	Strong evidence	9 U.S. studies, 1 in Crete, 2 in Australia. 10 studies among elementary school students and 2 studies among high-school students	Primary barrier is the lack of consistent PE policies across states and cities
Economic incentives	• Make funding more available for mixed use projects • Ensure that gasoline taxes cover all external costs of burning the fuel • Parking cash-outs where employees are given the cash value of parking • Performance zoning with the ability to add more footage for pedestrian-oriented streetscapes	Promising evidence	Some areas have implemented activities in this area, but they have not been systematically evaluated	
Point of decision prompts	• Signs placed by elevators and escalators to motivate people to use nearby stairs • Messages focus on health benefits or weight loss	Sufficient evidence	Diverse settings including shopping malls, train/bus stations, and a university library	Some evidence of higher effectiveness in obese individuals

(*Continued*)

TABLE 2 (*Continued*)

Category/Intervention	Examples of intervention components	Effectiveness*	Sites/populations involved	Other notes
Healthy eating				
Food and beverage availability in schools	• Food service changes including menu planning, food purchases • Training of food service workers • Improvement in nutrient content, presentation, and quality of school foods • Improved health curriculum • Improve classroom snacks	Insufficient evidence	Direct comparisons were limited by variations in dietary outcomes including fat, sodium intake, FV consumption, and behavior including food choices and purchases. Evaluation time frames varied from 1 month to 3 years. Interventions included multiple environmental components	Evidence across studies shows consistently positive results, but small effect sizes
Access to healthy ready-to-eat foods	• Worksite programs improving ready-to-eat foods purchased in cafeterias or vending machines • Community programs altered ready-to-eat foods provided in restaurants, churches, farmers' markets	Promising evidence	Multi-component interventions often included health education, labeling or pricing interventions	
Food pricing and incentives	• Reduce pricing of healthy vending machine foods • Reduce pricing in cafeterias • Food coupons for FV • Taxation of snack foods	Promising evidence	Price interventions took place in schools and worksite settings. Additional studies with systematic and robust evaluation designs for pricing interventions are needed	A growing number of studies applying economic principles and research to food behavior and intake show generally consistent and positive results

Nutrition labeling and information	• Point of purchase labeling in cafeterias, worksites, groceries • Restaurant menu labeling	Sufficient evidence	Several interventions included reduced pricing and promotion	Labeling of ready-to-eat foods has not been evaluated
Media and marketing policy	• Campaigns promoting education and awareness of healthy FV and foods • Campaigns limiting advertisements for competitive or foods of minimal nutritional value • Regulating food advertisements, particularly those targeted to youth	Insufficient evidence	There is a dearth of studies on dietary campaigns limiting media. Studies have addressed media influence on public education or awareness with mixed results	Media campaigns may be of particular benefit to youth

*When evidence of effectiveness is available from a systematic review (85, 145), it is noted; in other cases, estimates are based on review of the existing literature and the authors' judgment.

and private laws and regulations have been enacted that have dramatically changed the smoking environment in the United States.

The primary effect of clean indoor air regulations is to reduce the exposure of smokers and nonsmokers to harmful secondhand smoke (SS). SS exposure has been linked to a wide variety of harmful health effects that include lung cancer, pneumonia, bronchitis, nasal sinus cancer, and sudden infant death syndrome (93, 128). Smoking bans are, in general, extremely effective in reducing SS exposure. In the studies reviewed by the Community Guide, the median reduction in SS exposure is 60% for self-report measures and 72% for environmental measures (such as nicotine vapor or levels of particulates) (145). In addition to worksite studies, bans on smoking in restaurants and bars also result in lowered exposure rates for community residents (2). Studies have also shown that complete smoking bans are more effective at reducing ETS exposure than smoking restrictions (17).

An important secondary effect of clean indoor air laws is that as the number of smoke-free environments increases, so too does ecological and social pressure to reduce smoking. Cross-sectional analyses have indicated that the prevalence of adult smoking is significantly lower among workers in smoke-free worksites compared with workers at worksites with no smoking restrictions (19). Stronger evidence for the effects of clean indoor air policies on smoking behavior is found in a set of ten experimental or prospective studies reviewed in the Community Guide (145). These studies all show that implementation of strong clean indoor air regulations results in a reduction in rates of cigarette consumption, smoking prevalence, and increased cessation.

Restricting Youth Access to Tobacco Although it is illegal to sell tobacco products to minors, the vast majority (82%) of adults in the United States who have ever smoked tried their first cigarette before age 18, and 53% became daily smokers before age 18 (129). The purpose of youth access policies is to reduce the sales of tobacco products to teenagers and thus lower smoking prevalence by preventing or delaying smoking initiation.

Although states with more extensive youth access policies have significantly lower youth smoking rates (81), it has been difficult to demonstrate a causal link between implementation and enforcement of youth access policies and subsequent reductions in youth smoking. Programs that implement community and retailer education, sales monitoring, and policy enforcement can achieve significant changes in retail sales behavior, but this does not necessarily translate into changes in smoking behavior. Recent reviews of youth access interventions and purchase, use, and possession policies have summarized the lack of strong evidence, and they have argued that the difficulty in program monitoring, the ability of teens to acquire cigarettes from social sources, and the high cost of policy enforcement all suggest that tobacco control advocates should pursue other policies that are more cost-effective (132).

ECONOMIC ENVIRONMENT

Taxes and pricing One of the simplest and most effective ways to reduce smoking and tobacco use is to raise the price of tobacco products. Economic behavioral theory suggests that if cigarettes cost more, then fewer people will start smoking, existing smokers will smoke less often, and more smokers will attempt to quit. The primary way to influence price is through federal and state excise taxes. In 2005, the federal tax rate was 39 cents per pack and the median state tax rate was just under 70 cents per pack (4).

A large number of econometric studies have examined the relationship between tobacco prices and tobacco use (called elasticity) for adults and youth in both developed and developing countries. For adults, a 10% increase in cigarette prices is estimated to produce a 3% to 5% reduction in demand (77, 135). There is an emerging consensus that youth and young adults are even more sensitive to price than are adults (77). Estimates range from around 7% to 8% (51, 121) to as high as 14% (78). Recent studies have shown that higher prices affect smoking by lowering prevalence rates, lowering quantity of cigarettes smoked, decreasing the duration of smoking, and reducing initiation (30, 77). Finally, international studies have shown that in developed countries price elasticity is similar to that found for the United States, whereas developing and low-income countries show greater price sensitivity (60, 77).

In addition to their proven effectiveness, price increases through tax policy are attractive because of their broad reach. National and state excise taxes affect every tobacco consumer. Some have worried that increased prices would result in tax evasion and avoidance through increased purchase of black market cigarettes, increased use of the Internet to purchase low-priced cigarettes, or increased cross-border cigarette purchasing and smuggling. However, although studies have shown that consumers will purchase lower-priced cigarettes when they are readily available (e.g., if they live very close to an Indian reservation or bordering state with lower prices) (62), most studies show that, in fact, tobacco consumers find it difficult to avoid higher cigarette prices when they are introduced (112). For example, only around 5% of California smokers avoided higher prices by changing their purchase habits after a 50 cent/pack tax increase (36).

Reducing cessation costs Another way to shape the financial climate for tobacco control is to reduce the costs for cessation products and services for established smokers. Out-of-pocket costs for cessation are reduced primarily by increased public or private insurance coverage. A small number of studies have shown that reducing cessation costs can increase the number of people who use cessation services by approximately 7%, and increase the number of people who successfully quit using tobacco by approximately 8% (145).

Although insurance coverage of cessation services has been shown to be cost-effective, these services are still not widely covered in United States insurance and managed care systems (77). In the United Kingdom, the National Health System

has started to cover cessation pharmacotherapies, and early evidence suggests that this coverage has increased use of services, quit attempts, and short-term quit rates (77).

COMMUNICATION ENVIRONMENT

Advertising restrictions Tobacco products are one of the most heavily advertised and promoted products on the planet. Bans or restrictions on tobacco advertising have played an important role in tobacco control policy. In 1970 tobacco advertising was banned on television and radio. Billboard advertising of tobacco products was banned in 1999 as part of the Master Settlement Agreement, and as part of the same agreement tobacco companies agreed to stop advertising their products directly to youth.

Despite these advertising restrictions, there has been little evidence that partial restrictions have any effect on youth or adult smoking. One challenge is methodological—it is difficult to obtain relevant data, and the inability to examine large variations in tobacco advertising may make it impossible to detect causal relationships (77). Partial bans also leave open other marketing opportunities for the tobacco industry. For example, there is evidence that after the Master Settlement Agreement tobacco companies increased their direct marketing and bar promotion activities in an attempt to continue to reach young smokers (71).

However, recent data suggest that countries that adopt comprehensive advertising bans can expect to reduce tobacco use by approximately 5.4% (107). The societal cost to implement such national comprehensive bans is quite low, although there is stiff political pressure against adopting such bans.

Product warning labels The United States has required health warning labels on cigarettes since 1965, and most other countries require some type of labeling that supplies product or health information. Studies of warning labels like those used in the United States show that they have little effect. Warning labels are easily ignored, hard to recall, and do not stand out from other packaging elements (72). However, recent evidence from countries such as Canada and Australia, which have required larger, more colorful and graphic warning labels, indicates that labels can influence attitudes and behavior (7). For example, in Canada 44% of smokers were more motivated to quit after seeing the labels, and 21% of smokers who were tempted to have a cigarette did not because of the warning labels (83).

Promotion of Physical Activity

Specific strategies to promote physical activity with environmental and policy approaches were first proposed approximately a decade ago (70). At that point, the empirical basis for these interventions was quite limited. Since then, a substantial body of correlates research (61, 98, 106), along with a smaller number of intervention studies, has been published. Examples of environmental and policy

approaches to increase physical activity include walking and bicycle trails, funding for public facilities, zoning and land use that facilitates activity in neighborhoods, building construction that encourages activity, policies and incentives promoting physical activity during the workday, and policies requiring school-based physical education (66, 70, 109).

This section describes approaches to promotion of physical activity in six specific categories that bridge the domains in Figure 1. For some intervention categories there is a substantial and consistent body of literature, whereas for others the literature is sparse (although sometimes promising).

PHYSICAL ENVIRONMENT/ACCESS

Access to facilities Strategies often include providing access to facilities that are not currently available to the local population. A review of 19 studies in the physical activity and health literature showed consistent associations of accessibility of recreational facilities, opportunities to be active, and aesthetic qualities with physical activity in adults (61).

Interventions reviewed in the Community Guide involved the efforts of worksites, coalitions, agencies, and communities to create or provide access to places and facilities where people can be physically active. For example, interventions include providing access to nearby fitness centers or to weight and aerobic fitness equipment in community centers and creating walking trails. Many of these studies also incorporated components such as training on equipment, health behavior education and techniques, seminars, counseling, risk screening, health forums and workshops, referrals to physicians or additional services, health and fitness programs, and support or buddy systems.

Quantitative estimates of effect are based on ten studies (66). In eight arms from five studies the median net change in aerobic capacity was 5%. In four arms from three studies the median net change in the frequency of physical activity was 48%.

Urban planning and policy There have been dramatic changes in the urban landscape over the past 50 years (15). Muller has described the period from 1945 to the present as the "Freeway Era" in which the automobile is no longer a luxury but has become essential for commuting, shopping, and socializing (92). This trend also contributed to the advent of the suburban ring and to the accompanying freeway segments that now girdle most central cities in the United States. The migration to suburban environments is closely linked with the evolution of zoning policies over the past century (110). For example, landmark cases such as *Euclid v. Amber Realty* (1926) established the importance of local zoning laws in shaping the patterns of growth in urban areas.

Researchers in transportation and urban planning have examined the relationship between community design variables and walking or cycling for transportation. A review of 14 studies consistently shows that people walk and cycle more when their neighborhoods have higher residential density, a mixture of land uses

(e.g., shops are within walking distance of homes), and connected streets (e.g., grid-like pattern instead of many cul-de-sacs) (106).

The Community Guide identified two types of interventions through urban planning and policy (57). The first set are urban design strategies that involve street-scale changes and the second are land use policies that support physical activity in small geographic areas, generally limited to a few blocks. Another closely related group of interventions focus on community-scale changes that are similar to street-scale changes but involve a much larger geographic area (e.g., an entire community).

Among the total group of 19 studies, 16 were cross-sectional and 3 had pre- and post-designs. The metrics used varied widely, including outcomes such as percent of the population walking to work; percent of household pedestrian trips compared to transit and auto trips; average frequency of walking trips to shopping area each month; and self-reported number of minutes walked per week or per month, percent of trips made by walking or biking, and distance and duration of walking trips. Median net effects ranged from 35% for street-scale interventions to 161% for community-scale interventions.

Transportation policy Transportation policy can have substantial impacts on travel choice (e.g., walking versus driving). Changes in transportation policy may influence the rate of physical activity and may also be beneficial to air quality and traffic congestion.

This group of interventions rely on policy measures such as roadway design standards, expansion of public transportation services, or subsidization of public transportation (i.e., transit passes). In the review of the Community Guide only three studies were identified for this intervention strategy. Due to too few qualified studies, this intervention strategy has insufficient evidence to make any type of recommendation. This is an important area for future research.

School-based physical education Interventions in this category involve modified curricula and policies to increase the amount of time students spend in moderate or vigorous activity while in physical education (PE) classes. This modification is accomplished in numerous ways including (*a*) adding new (or additional) PE classes, (*b*) lengthening existing PE classes, or (*c*) increasing moderate to vigorous physical activity of students during PE class without necessarily lengthening class time. Examples of specific interventions include changing the activities taught (e.g., substituting soccer for softball) or modifying the rules of the game so that students are more active (e.g., having the entire team run the bases together if the batter makes a hit). Many of these interventions also included the presentation of information on cardiovascular disease prevention, rendering it difficult to separate the effects of health education and modified PE.

Among the 13 studies reviewed, outcome measures included energy expenditure, percent of class time spent in activity, minutes spent in activity, and self-reported type and frequency of physical activities outside of school (66). Five

arms from four studies showed increases in the amount and percent of time spent in physical activity in PE classes. The net increase in the amount of PE class time spent in physical activity was 50%. The net increase in the percent of class time in physical activity was 10%, with an additional study reporting a 762% increase from a very small baseline value. Three arms from two studies showed increases in energy expenditure as well. Fourteen arms from eleven studies showed increases in aerobic capacity, with a median of 8%. There is also evidence that these school-based changes can be maintained and institutionalized after research funding ends (58).

ECONOMIC ENVIRONMENT

Economic incentives There is growing interest in understanding the economic impact of physical inactivity and the economic interventions that might be effective in promoting activity. The economic consequences of inactivity are substantial, with direct medical expenses estimated at $76 billion in year 2000 in the United States (102).

When considering economic interventions, it is important to consider that economics, especially those influencing the transportation infrastructure, strongly influence individual-level transportation choices (87). A comprehensive set of potential economic intervention strategies was published by Pratt and colleagues (101). These interventions are closely related to those in transportation policy noted above; however, they specifically focus on how financial incentives and disincentives influence physical activity patterns.

There are few empirical data showing the effectiveness and magnitude of effects of these economic interventions. At this point, they represent a promising set of strategies that should be implemented and evaluated (so-called natural experiments).

COMMUNICATION ENVIRONMENT

Point-of-decision prompts Cues to make use of an environmental feature are important in promoting physical activity. The use of cues comes via point-of-decision prompts, e.g., signs placed by elevators and escalators to motivate people to use nearby stairs. Messages on the signs recommend stair use for health benefits or weight loss. Signs are thought to be effective in one of two ways: by reminding people already predisposed to becoming more active, for health or other reasons, about an opportunity at hand to be more active or by informing them of a health benefit from taking the stairs.

The Community Guide reported on six studies in its 2002 review. These studies were conducted between 1985 and 2000. Across this group of studies, baseline rates of stair use were generally low, with all but one under 12% (range: 4.8% to 39.6%). The range of effect sizes varied from a 5.5% net increase to 128.6%. Since the publication of Kahn et al. (66), there are at least ten additional original studies in the peer-reviewed literature. These newer studies begin to address effects across

ethnic groups (25) and the effects of poster size and content in promotion of stair use (69).

Promotion of Healthy Eating

Trends in diet quality show increases in consumption of energy-dense, low-nutrient foods, associated with the development of a variety of chronic diseases (43, 65, 96, 139). To reverse these trends, public health practitioners have begun to focus more on changing environmental and policy factors that promote healthy eating (8, 53). These interventions fall within five categories: pricing or economic approaches, nutrition labeling or information strategies, availability of nutritious foods in schools, access to healthier ready-to-eat foods, and media or public education approaches. These are organized according to the broad headings in Figure 1.

PHYSICAL ENVIRONMENT/ACCESS

Food and beverage availability in schools Policies to assure a healthy school environment can have repercussions on the approximately 52 million students who attend school and the 28 million children participating in the National School Lunch Program (NSLP) (26). Competitive foods and beverages offered à la carte in schools meet minimal standards for nutrition content. These à la carte foods are easily accessible and affordable to children in 43% of elementary schools, 89% of middle schools, and 97% of high schools that have vending machines or other school food services outside of school lunch programs (137).

Much of the research in schools is designed to improve availability of healthy foods and beverages by combining multicomponent behavioral and environmental interventions. These approaches generally improve nutrition intake by altering food services, preparation and choices in cafeterias and vending machines; offering promotional activities for healthy foods and beverages; enhancing nutrition content of classroom curricula; and informing and educating parents and teachers (35, 55, 56, 64, 82, 95, 100, 125). Policies in accordance with CDC recommendations for school-based healthy eating programs have also been shown to be effective in improving health outcomes (131). School-based interventions report small but consistent improvements in student intake of fruits and vegetables (FV) (52, 82, 95, 100), decreases in fat intake (35, 55, 125), and choices of healthier food options (59).

A report by the Institute of Medicine in 2005 concluded that availability of healthy foods alone may not be sufficient to promote positive choices for children when competitive foods high in fat and sugar are easily accessible (26). Environmental interventions are most effective that make healthy options available while also restricting the availability of competitive foods (26). The inclusion of pricing strategies and assuring information about healthy foods also represents promising environmental strategies for improving intake of youth in school settings (119).

Access to healthy ready-to-eat foods Foods obtained away from home are often ready to eat and prepared by another vendor, meaning that the consumer has little control over nutrient content or portion size (41). Ready-to-eat foods typically offer portion sizes 2 to 5 times larger than those found in previous decades and account for over one third of the total energy intake of the population (76, 134, 144). The convenience of ready-to-eat foods in community restaurants, fast food venues, or local stores, as well as in worksite cafeterias and vending outlets, plays a role in the population trend of increasing caloric intake.

Environmental intervention studies addressing ready-to-eat foods have sought to improve the quality of offerings across a variety of settings. Several worksite interventions have reported improvements in food preparation and access to healthy ready-to-eat foods as effective strategies for increasing FV consumption or reducing fat intake (6, 99, 115). Community-based studies have evaluated improved FV or dietary composition in church-based settings (20), restaurants (27, 32, 50), and hotels or entertainment venues (138). These studies varied in research design, length to follow-up (from 1 month to 4 years) and primary outcomes. However, in general, each reported outcomes of improved food preparation or access; three of the studies increased customer requests for healthy entrees (27, 32, 50). One case study reported strategies that resulted in the altered policies that assured neighborhood access to healthy food retailers (136). To date, there is a dearth of environmental studies testing interventions in fast food restaurant venues.

ECONOMIC ENVIRONMENT

Food pricing and incentives Reviews of agricultural and nutritional food data and policies note increases in food intake occurred in conjunction with the commercialization of the food supply. This is defined by incentives to improve sales though marketing and increasing demand for food (123, 124). Between 1985 and 2000 the price of fresh fruits and vegetables increased 118% compared with a 20% to 46% increase in the price of calorie-dense foods and beverages of minimal nutritional value (e.g., snacks and soda) (31). Economic principles have established that decreases in food pricing increase consumption, as evidenced by supersizing, which may partially account for the reported increase in intake of energy-dense foods (38, 88, 143).

Recent intervention research has applied the principle of price reduction to sales and consumption of low-fat snacks in vending machines. A series of studies in schools and communities demonstrated that progressive lowering of prices of low-fat snacks yielded significant increases in sales coinciding with the amount of price reduction (45). A 50% price reduction of fresh fruits and vegetables in school cafeterias resulted in two- to fourfold increases in sales of carrots and fresh fruit (54). A review by Glanz and colleagues reported positive impacts from price reduction coupons used by seniors and WIC participants at farmers' markets (49). Others have also reported enhanced impact on dietary intake when coupons were combined with education (5).

Increases in food or beverages taxes have been suggested as a means of decreasing consumption and increasing revenue for health promotion programs. Studies examining the expected impact of snack food taxation concluded a 1% tax would only minimally affect consumption of salty snacks (e.g., potato chips) by 0.28 ounces or 42 calories per person per year. A 20% tax would reduce consumption by 5.54 ounces per person per year, or 830 calories, and would generate $40 to $100 million in tax revenues (73, 74). As of 2000, 19 states and cities have implemented policies on taxing snack foods, soft drinks, candy or chewing gum; however, impact data on these policy initiatives are not yet available (13).

Environmental interventions targeting food costs as a means of altering intake are promising, but the lack of robust research studies to date on outcomes of these policies limits our ability to predict their effectiveness.

COMMUNICATION ENVIRONMENT

Nutrition labeling and information Empirically sound information is critical if the public is to make informed choices regarding dietary intake. The Nutrition Labeling and Education Act was implemented in 1990 (45) to provide the public with accurate information and food facts to guide choices. Labels are available on over 95% of all processed foods and influence purchasing patterns of the public (94). However, nutrition labels are frequently lacking on foods eaten away from home, at restaurants, vending machines, or fast food venues, which account for 46% of all food dollars spent (31, 33, 79, 103). This suggests that consumers are not fully informed about the content of much of what they are eating.

Reviews have been conducted of worksite, community, and school interventions addressing the effectiveness of nutrition labeling on purchase or intake (8, 47, 52, 85). Labeling of vending machine foods has been shown to further enhance consumption of reduced price low-fat foods in school settings (42, 44). A review by Matson-Koffman et al. identified 11 studies that included labeling in interventions that showed improvement in the selection of healthy foods in worksites and community settings that included restaurants and grocery stores (85).

Glanz and colleagues (47, 49) reviewed restaurant-based environmental and policy interventions including point of purchase (POP) studies defined by the use of shelf labels or signage to specify healthy food choices (47, 49, 65). Although several POP studies lacked rigorous design elements, the results generally supported feasibility and improved knowledge. Other studies of more rigorous design reported supermarket POP programs significantly reduced intake of fat in meats and fried foods (27), increased sales of labeled grocery foods (49), and improved knowledge and intake of target foods (85).

There is limited information to validate the effect of labeling on the nutrient intake of the population. However, knowledge and behavioral outcomes associated with the current nutrition-labeling program suggest merit in policies that extend labeling to include foods eaten away from home.

Media and marketing policies Advertising and marketing are intrinsically linked to the food supply and intake of the population (46). Food-marketing practices have emphasized the convenience, low cost, and increased availability of energy-dense foods (65). The food industry spends $50 per person per year to advertise foods compared with $1.50 spent by the USDA (46). Food and beverage advertisers collectively spend 10 to 12 billion dollars a year to reach children and youth who see 40,000 TV ads per year promoting snack foods and beverages (26, 67). This repeated exposure to food commercials influences children's preferences and food requests, while ads can also contribute to confusion about the relative health benefits of certain foods.

Media campaigns designed to balance or enhance health messages addressing dietary change have often been conducted in combination with other multicomponent interventions (9, 29, 32). Reviews of several studies targeting nutrition showed that results have been mixed, with improvements cited in the number of adults who switched to low-fat milk (104), or achieved small improvements in FV (39, 117), or in fat consumption (40). Others found improvements in awareness or intention to alter diet but not in consumption (130). Campaign effectiveness is influenced by the intensity of message exposure, reach, timing, and cost.

There is limited evidence of effectiveness for nutrition policies that regulate media messages addressing unhealthy food intake. However, given the success of this approach in other areas (e.g., tobacco control), regulation of media messages remains a promising strategy and an important area for future research.

CHALLENGES AND LESSONS LEARNED

Chronic diseases, including cardiovascular diseases, cancers, diabetes, stroke, and respiratory diseases, account for the majority of the global disease burden (140). Other reviews (85, 145) and ours suggest there are numerous approaches with significant potential for reducing the incidence of chronic diseases.

In developing and implementing these interventions, public health agencies and other community-based organizations face several particular challenges. First, chronic diseases are often not seen as a crisis compared with other health threads such as infectious diseases. Second, the "pay-off" for chronic disease prevention efforts occurs in future years not in weeks or months. Third, the public often shows more concern about involuntary risks (e.g., potential exposure to a chemical waste site) than about voluntary risks (e.g., cigarette smoking), even though the voluntary risks account for the largest burden from chronic diseases. Fourth, many communities lack the local data on chronic diseases and their risk factors for priority setting and program evaluation. This issue is beginning to be addressed (e.g., statewide risk factor data) but remains a serious constraint at the county, city, and neighborhood levels. And finally, sufficient resources have not been committed to chronic disease control efforts. Public health funding dedicated to chronic

disease activities is disproportionately low in relation to the public health burden of chronic diseases (21).

In spite of these challenges, there have been numerous successes in implementing environmental and policy interventions to reduce chronic disease risk (22–24, 142). From these experiences, we can draw useful lessons.

The issues that follow are common across all three risk factors. There also are certain differences that deserve mention. The "rules of engagement" for the industries involved need to be carefully considered (142). It is unlikely that constructive dialogue with the tobacco industry will occur, yet for other areas (e.g., physical activity), well-defined partnerships with industry [e.g., athletic shoe manufacturers (97)] may prove beneficial. There are also differences in risk behaviors (e.g., smoking) that should be totally avoided versus necessary behaviors (e.g., eating) that represent a range of risk. Finally, there is a much larger body of evidence on intervention-related studies for tobacco than for the other two behaviors.

Start with Environmental and Policy Interventions

Based on public health movements, policy and environmental change is key to initiating and sustaining systematic change (34). In many cases, control of chronic diseases is most effective if environmental and policy approaches are the earliest focus of change. These approaches can be low cost, high reach, and tend to provide supportive environment for later targeted interventions. For example, if one is implementing a community-based program to promote energy balance (healthy eating and physical activity), there is little chance of effectiveness if there is a lack of access to healthy foods or places for activity. This fits well with the World Health Organization's statement in its Ottawa charter that "Healthy choices need to be the easy choices" (142). We suggest that an opportune starting point for environmental and policy interventions should involve the three domains in our framework (the left-hand rectangles in Figure 1).

Think Comprehensively and Across Multiple Levels

Drawing on the process of assembling systematic reviews, as well as evidence from state and local chronic disease-prevention efforts (11, 22, 80, 114, 145), comprehensive interventions that address multiple levels of an ecological framework are more effective. For example, to address childhood obesity (through healthy eating and increased activity), multilevel approaches are needed to include schools that sell or serve only healthy foods and beverages, stronger policies for school physical education, and zoning and subdivision ordinances that support and encourage walking and bicycling (26).

Make Use of Economic Evaluations

There is a considerable body of information on economic evaluation of tobacco control interventions (60) and growing evidence for physical activity and diet.

In tobacco control, the estimated net economic benefit of a national ban on smoking in nonresidential buildings was between $42 and $78 billion per year (91). In one of the few economic evaluations in physical activity, Wang and colleagues (133) examined the cost of trail development per trail user in Lincoln, Nebraska. The annual cost per user was $235 (range = from $83 to $592), whereas per capita annual medical cost of inactivity was $622. Studies like these supply powerful information for health advocates and policy makers.

Make Better Use of Existing Tools

This review highlights the importance of systematic reviews, such as those found in the Community Guide. Another important tool is Cancer Control PLANET (1). The PLANET portal provides access to data and resources that can help planners, program staff, and researchers to design, implement and evaluate evidence-based cancer control programs. Active training and dissemination efforts are needed to increase the use of tools like the Community Guide and PLANET, which are currently underutilized (14, 68, 84).

Understand Local Context

When implementing environmental and policy interventions, it is important to keep in mind that intervention effectiveness does not necessarily equate with intervention feasibility (e.g., a highly effective intervention may be very expensive to implement). To better understand feasibility, assessment of local context is essential. The local context for an intervention should be assessed in conjunction with local data (37, 122) and with information on how to apply interventions found in systematic reviews like the Community Guide (145).

Understand the Politics

Policy interventions are by nature political. Policy makers have to sell, argue, advocate, and get re-elected in light of available political capital. Their interests often tend to be shorter-term and are keyed to an election cycle. Even in the presence of sound scientific data on how to prevent chronic diseases, ideas are sometimes not ready for policy action—owing to lack of public support or competing policies. Practitioners working in governmental agencies have to learn how to influence policy development without direct lobbying. This often involves working in coalitions that can mobilize support and advocate for specific issues. These broad-based coalitions have been essential in achieving progress in tobacco control (142).

Build New and Nontraditional Partnerships

The importance of transdisciplinary partnerships has long been recognized in public health (63, 105). Often the goal of those partnerships is to enhance the work of the public health partners. In many cases, successful implementation of

environmental and policy interventions will require new skills and nontraditional partnerships with people and organizations not working directly in public health. For example, to address the major structural barriers to physical activity in U.S. cities, urban planners, transportation experts, and persons working in parks and recreation are essential collaborators in developing the environment and the political will for activity-friendly communities (108). To address the food environment, partnerships might be explored with organizations engaged in food packaging and processing, marketing, or sales.

Address Health Disparities

In both developed and developing countries, poverty is strongly correlated with poor health outcomes (120). Most of the existing intervention literature has been conducted among ethnic majority populations and higher-income populations. A challenge for the application of environmental and policy strategies involves a better understanding of how interventions apply within populations with large health disparities. Policy interventions have the potential to equalize the environment in a way that may significantly reduce the growing disparities.

Learn from Other Parts of the World

There are many examples of successful environmental and policy approaches worldwide that can provide guidance in the United States. For example, European studies have suggested the importance of policy orientation (i.e., a collection of strategies, policy statements, and committee reports that express the will of the government). Countries that place a higher emphasis on opportunities and infrastructure for physical activity appear to have higher rates of activity (118). Policies designed to inform and alter public purchasing patterns (i.e., adoption of labeling systems countrywide, information on soft drink versus water campaigns) have improved health outcomes of the population (9).

Conduct More and Better Policy Research

We still have a great deal to learn about environmental and policy approaches. Rich opportunities for policy research may take a number of forms: (*a*) identifying relevant policies (surveillance); (*b*) understanding the determinants of establishing policy; (*c*) exploring the process of developing and establishing policy; and (*d*) assessing the outcomes of policy implementation. In these studies, the policy can be either the independent or dependent variable.

In mainstream epidemiology, the most rigorous design for hypothesis testing is the randomized controlled trial (75). However, a randomized design is seldom useful in policy research because the scientist cannot randomly assign exposure (the policy). Therefore, quasi-experimental designs (e.g., ecologic studies, time-series designs) are likely to be more useful for many policy-relevant issues. Policy research can still be sophisticated in the absence of randomized designs (e.g., the

multilevel nature of policy—federal, state, local—leads to multilevel modeling strategies) (3, 10, 113, 116).

CONCLUSION

There is now a considerable body of evidence showing that environmental and policy interventions are effective in preventing chronic disease risk factors. The evidence is strongest for tobacco use reduction, yet sizeable and growing in volume for promotion of physical activity and healthy eating. The large and increasing burden of chronic diseases can be reduced through systematic and sustained implementation of environmental and policy interventions. Before implementing an array of individual-level programs to prevent chronic diseases, practitioners should consider the power of environmental and policy approaches to set the stage for other interventions.

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